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ABSTRACT

Structural equation models of annual federal expenditures for elementary and secondary education and for higher education were estimated using time-series data extending from 1947 to the later 1970s. The pattern of expenditures for elementary and secondary education proved to follow closely that for higher education. Factors affecting federal expenditures for elementary and secondary education either directly or indirectly (by affecting expenditures for higher education) have included which political party controlled the House of Representatives, the size of the federal budget surplus or deficit, the level of defense expenditures, and the number of arrests of persons under 18 years of age. Testing the forecasting accuracy of the models incorporating these factors revealed that forecasts diminished in accuracy when extended beyond 1 year, that multivariate forecasting techniques proved superior to univariate forecasts based on linear regression, and that a three-period, moving average model performed better than multivariate models when absolute accuracy of single-year forecasts was the sole criterion. Multivariate models provided greater insight into factors influencing change in time series, however, and appeared likely to be more accurate when influencing factors undergo sudden change. Appendixes present illustrative figures. (PGD)

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Technical Report No. 14

Models and Forecasts of Federal Spending for Elementary and Secondary Education

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Kevin J. Gilmartin

Prepared by

SAGE
STATISTICAL ANALYSIS GROUP IN EDUCATION

For the

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TECHNICAL REPORT NO. 14

MODELS AND FORECASTS OF FEDERAL SPENDING FOR ELEMENTARY AND SECONDARY EDUCATION: WORLD WAR II TO THE PRESENT

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June 1980

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MODELS AND FORECASTS OF FEDERAL SPENDING FOR ELEMENTARY AND SECONDARY EDUCATION: WORLD WAR II TO THE PRESENT

Analyses of repeated-measures, or time-series, data that examine the effects of social and fiscal conditions on monetary policies are well known to the study of econometrics. With increasing frequency, the methods of time-series analysis are also being used to study change and to evaluate policy alternatives in a variety of social welfare areas (see, for example, Anderson, 1973, 1978; Land & McMillen, 1978; and Cohen & Felson, 1979). One chapter in a new text on social indicators research, entitled Handbook of Social Indicators: Sources, Characteristics, and Analysis (Rossi & Gilmartin, 1980) is devoted entirely to the description and discussion of various types of time-series analyses and reviews the applicability of these analyses to studies in a variety of social welfare areas. The present paper applies one type of this methodology to the area of educational finance, examining the policy-relevant forces and conditions that have shaped the pattern of federal expenditures for elementary and secondary education since 1947. First, a brief review of the issues associated with federal spending in this area is presented. Next, a description is given of the methods of analysis that were used. Four expenditure models based on time-series analysis are then presented and discussed. Finally, a comparison is made of forecasts based on these models and forecasts based on several methods of univariate projection.

Issues Concerning Federal Education Expenditures

Federal involvement in elementary and secondary education has been characterized by continuing debate concerning the extent to which federal, state, and local agencies should contribute to providing educational services. Initially, the principal issue was whether the federal government should play any role at all in the educational process. Arguments opposing federal aid to education focused on the impossibility of equalizing educational opportunity, the lack of need for federal assistance, the threat of

federal aid to local control, the unconstitutionality of federal intervention, the costs of federal intervention, the discouragement of individual initiative, opposition by the public to federal support, the lack of historical precedent for this support, and the infringement of individual freedom (Tiedt, 1966). Those in favor of providing federal assistance to the schools took issue with each of these arguments and, in turn, they claimed that federal support was desirable because of the broader federal tax base, the mobility of the population, and the greater efficiency of federal taxes.

When the federal government began its support of education, the principal issue concerned funding strategy. Schools and their representatives in the education lobby and in Congress argued for general, or unrestricted, aid. Their main contention was that education-related needs could best be determined (and money, therefore, could best be allocated) at the local level. Moreover, they argued that federal involvement in the allocation of educational resources at the local level would distort local educational goals (Thomas, 1975) and reduce the effectiveness of local supervision and management of education (Cordasco, 1966). Opponents of general aid worried that such unrestricted assistance would be misused. In addition, they tended to favor categorical assistance programs for political reasons (Thomas, 1975).

At the present time, categorical rather than general assistance is the prevalent federal funding strategy. Current debate concerning the educational partnership between the federal government and state and local education agencies is focused on the degree to which the federal government should have a voice in determining the conduct and the content of educational practice (Krathwohl, 1977; Goldhammer, 1978; Rossi, 1979).

As noted by several analysts, advocates of active federal participation stress the need for federally supported evaluations (M. McLaughlin, 1975; Rossi, D. McLaughlin, Campbell, & Everett, 1977), for federally supported attempts to promote educational innovations (Berman & M. McLaughlin, 1978), and for unified federal policy with respect to educational research and development (Singletary, 1978). These advocates point out that the federal

government is concerned about meeting the special education-related needs of individuals. They would argue that such concern is reflected in statements of present and future policies (Berry, 1977), in discussions of the purposes and effects of federally sponsored programs (Chadima & Wabnick, 1977), and in the planning of research efforts (House of Representatives, 1978).

Analysts have pointed out that those who oppose an active, participatory federal role in determining the conduct and content of educational research and practice warn of such involvement inevitably leading to federal control (Breneman & Epstein, 1978; Federal Focus, July 1978). These opponents have argued that the federal government's reliance on requests for proposals (RFPs) to encourage research activities may negatively affect the productivity of researchers (Havighurst, 1978). Furthermore, they argue that federal efforts to develop curriculum materials and guidelines for the schools have eroded concern for important educational goals (Wise, 1978). Finally, it is common for opponents of an active federal role to point out the paperwork burdens that are typically associated with federal support (Bender & Breuder, 1977).

While prospects of reduced federal educational resources may temper the concern for federal control of education (Breneman, 1978), both the distribution of the resources that are available and the level of federal involvement in the educational process that results from this distribution will raise important policy issues for the next decade. If these issues are to be analyzed and addressed effectively in the future, more must be learned of the social, political, and economic conditions that have influenced the pattern of federal spending for education in the past.

Methods of Analysis

To examine the factors that have influenced federal policymaking efforts in education and have thereby shaped the economic partnerships among federal and state governments and local education agencies, it is necessary to work with trend data. In this paper, structural equation

modeling is used to examine relationships among trends describing social, political, and economic conditions and federal education expenditures.

The time series that describe federal expenditures for elementary and secondary education and higher education were taken from the U.S. Department of Health, Education, and Welfare, Social Security Administration, Office of Research and Statistics publication entitled Social Welfare Expenditures under Public Programs in the United States, 1929-1966 and from January issues of the Social Security Bulletin. These series include all costs associated with the provision of educational services under federal programs mandated by public law. Costs for school construction and federal administration of educational programs are not included. The data sources for all the other series included in the structural equation models were Historical Statistics of the United States, Colonial Times to 1970 and Statistical Abstract of the United States, published by the U.S. Department of Commerce, Bureau of the Census. Figure 1 shows the levels of annual federal expenditures for elementary and secondary education and for higher education corrected for inflation. Figures illustrating the levels of the other series included in the models are presented in the appendix to this paper.

Multiple regression equations of the form $Y = a + b_1X_1 + b_2X_2 + \ldots + b_KX_K + e$ have been estimated for time-series data extending from 1947 to the present. Because the relationships among these series are examined over time, the subscript t is used to specify no lag between the observation of an independent variable and the dependent variable observed in year t, the subscript t-1 is used to specify a lag of one year, and so forth.

For this analysis, two types of multiple linear regression equations were estimated. First, the relative influences of independent variables on the levels of annual federal expenditures were estimated. In this type of equation, variables are examined that are believed to affect long-term trends in federal spending for education. The second type of equation, which estimates the relative influences of independent variables on the yearly changes in levels of federal expenditures, examines those variables

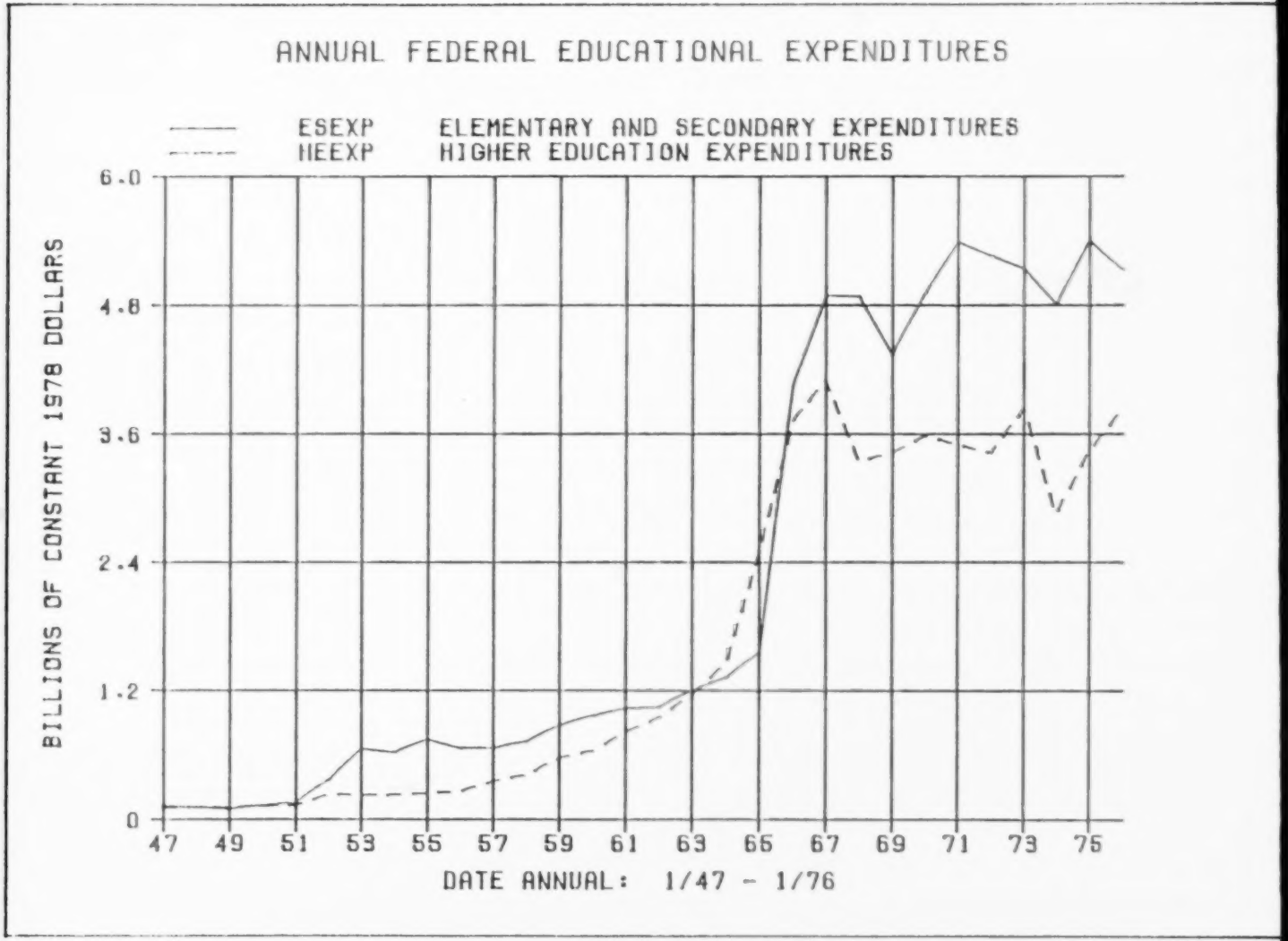

Figure 1. Annual federal expenditures for elementary and secondary education and for higher education, 1947-1976.

that are believed to affect short-term fluctuations in federal spending for education. In these analyses, yearly changes in federal education expenditures are expressed as a percentage change from the previous year. Because these two types of equations examine the pattern of federal education expenditures from different temporal perspectives, they each contribute meaningfully to an understanding of the social, political, and economic conditions that can affect education spending at the federal level.

The performance of the two types of expenditure equations presented below can be evaluated in several ways. First, t-ratios for each estimated regression coefficient, which are reported in parentheses beneath the coefficients, indicate the statistical significance of each of the independent variables in the equations. Second, adjusted and unadjusted multiple correlation coefficients (R^2s) indicate the percentage of variance associated with federal expenditures that is accounted for, or "explained," by the independent variables (with and without correction for the number of independent variables that are included in the equations). Third, standard errors associated with estimates of expenditures indicate the extent to which individual estimates were incorrect over the period of time included in the analysis (i.e., 1947-1976). Fourth, the percentage error of one-period-ahead forecasts made with the equations indicates the extent to which these models are capable of producing accurate estimates of future values.

The fifth and perhaps most important types of indicators of the performance of the four expenditure equations are the Durbin-Watson d and h statistics, which assess the amount of autocorrelation, or serial dependence, among ordinary least squares (OLS) residuals. These residuals are the year-by-year "errors" in the regression model, that is, the differences between the estimated and the actual levels of expenditures for each year. If residuals are autocorrelated, so that knowing the error of estimate for one year would allow one to predict the size and direction of error for a subsequent year, then OLS estimates will appear to be more reliable than they in fact are. For example, residuals that are highly correlated over time will cause the variance of least squares estimates to be underestimated, resulting in the miscalculation of confidence intervals and t-ratios

for these estimates. As no evidence of autocorrelation among residuals was found in these four expenditure equations, there is no reason to suspect that the precision of least squares estimates in these models is overestimated.

Annual Federal Spending for Elementary and Secondary Education

Two factors are especially important for understanding the pattern of annual federal spending for elementary and secondary education since 1947. First, as is typical of many federal initiatives, multi-year authorizations of funds have introduced considerable stability into the total dollar amounts for education that have been provided from one year to the next. For this reason, an important determinant of the amount of federal funds allocated to elementary and secondary education in a given year is the amount provided in the previous year. This influence of past levels of support for education on current levels of expenditures is represented on the right-hand side of equations (1) and (2) by the lagged dependent expenditure variables (i.e., $ESEXP_{t-1}$ and $HEEXP_{t-1}$).

The second factor that is essential for understanding federal expenditures for elementary and secondary education is the commitment of the federal government to support of higher education programs. Since the start of World War II, when federal involvement in education increased dramatically, the major federal initiatives in support of elementary and secondary education have been immediately preceded by increased federal spending for higher education.

The Lanham Act of 1941 first authorized federal support for elementary and secondary schools serving pupils whose parents lived on military installations. This act was considerably expanded in 1950, and by 1966 funds were being distributed to 316 of the 437 congressional districts and to 25% of all students in public elementary and secondary schools. Appropriations authorized by the expansion of the Lanham Act in 1950 followed increases in federal expenditures for research and development activities

in colleges and universities. Motivated by the experience of World War II and the fear of a third international conflict in Korea, federal support for higher education and its research capabilities was substantially increased in the 1950s over what it had been in previous years (Carnegie Council on Policy Studies in Higher Education, 1975).

The launching of Sputnik created a new concern for the nation's technological abilities. This concern led to passage of the National Defense Education Act of 1958, which specified how federal monies (approximately $1.6 billion) were to be used by (1) elementary and secondary schools for instruction in scientific and technical areas, guidance and counseling, testing services, and the development and use of instructional media; (2) higher education institutions for research and research-related activities; and (3) college and university students to meet tuition costs. The objectives of this act related to national defense were to be accomplished in the short term by the investments in higher education. The national defense benefits that would accrue from increased investment in elementary and secondary schools were to be realized later, when better-trained students attended colleges and universities with better-equipped facilities and better-trained faculties.

Lastly, Title I of the Elementary and Secondary Education Act, which was authorized in 1966 and provided more than $1 billion to the schools, was immediately preceded by dramatic increases in federal support for students and research and development activities in higher education institutions. The Higher Education Facilities Act of 1963 reached its peak funding level in 1966, and the Higher Education Act of 1965 contributed significantly to the over 200% increase in federal funding of higher education that occurred between 1963 and 1967 (U.S. Department of Health, Education, and Welfare, 1970). In 1966, more than one-half of all federal support to higher education was targeted for research and development (National Science Foundation, 1967), and the remainder was divided between facilities improvement and loans for students, who were enrolling in record numbers (Orwig, 1971).

The influence of federal concern and federal budget outlays for higher education on federal elementary and secondary expenditures is represented by the higher education expenditure variable on the right-hand side of equation (1). This variable together with the lagged dependent variable and a lagged variable describing the availability of federal funds during a given fiscal year (the amount of the federal budget surplus or deficit) account for over 98% of the variance in annual federal spending for elementary and secondary education. Figure 2 compares estimated levels of expenditures for elementary and secondary education based on equation (1) to the actual expenditures made for the period 1948-1976.

Equation (1), Federal Spending for Elementary and Secondary Education

$$\underset{}{ESEXP_t} = \underset{(.03)}{.002} + \underset{(9.0)}{.60ESEXP_{t-1}} + \underset{(8.0)}{.65HEEXP_t} + \underset{(2.6)}{.01SURPLUS_{t-1}}$$

Where,

ESEXP = Elementary and secondary expenditures (federal)

HEEXP = Higher education expenditures (federal)

SURPLUS = Federal budget surplus (or deficit)

R^2 = .984 STD ERROR = $.28 billion DW-d = 2.1

R^2_{ADJ} = .983 df = 28 DW-h = -.4

In estimating equation (1), the effects on federal elementary and secondary expenditures of enrollment, school district consolidation, education lobby activities, and the abilities of state and local governments to pay for the increasing costs of school operation were evaluated. Indicators of total enrollment in elementary and secondary schools and the enrollments of minority groups in these grades were not statistically significant determinants of elementary and secondary expenditures. Too few data points in series describing the numbers of school districts, elementary and secondary schools, and the number of one-room schoolhouses prevented confident estimates of the statistical significance of these indicators. However, the estimates that were derived were not statistically significant. An indirect measure of education lobby strength, total membership in the National Education Association from 1947 to the present, was not correlated with federal education expenditures. Lastly, measures

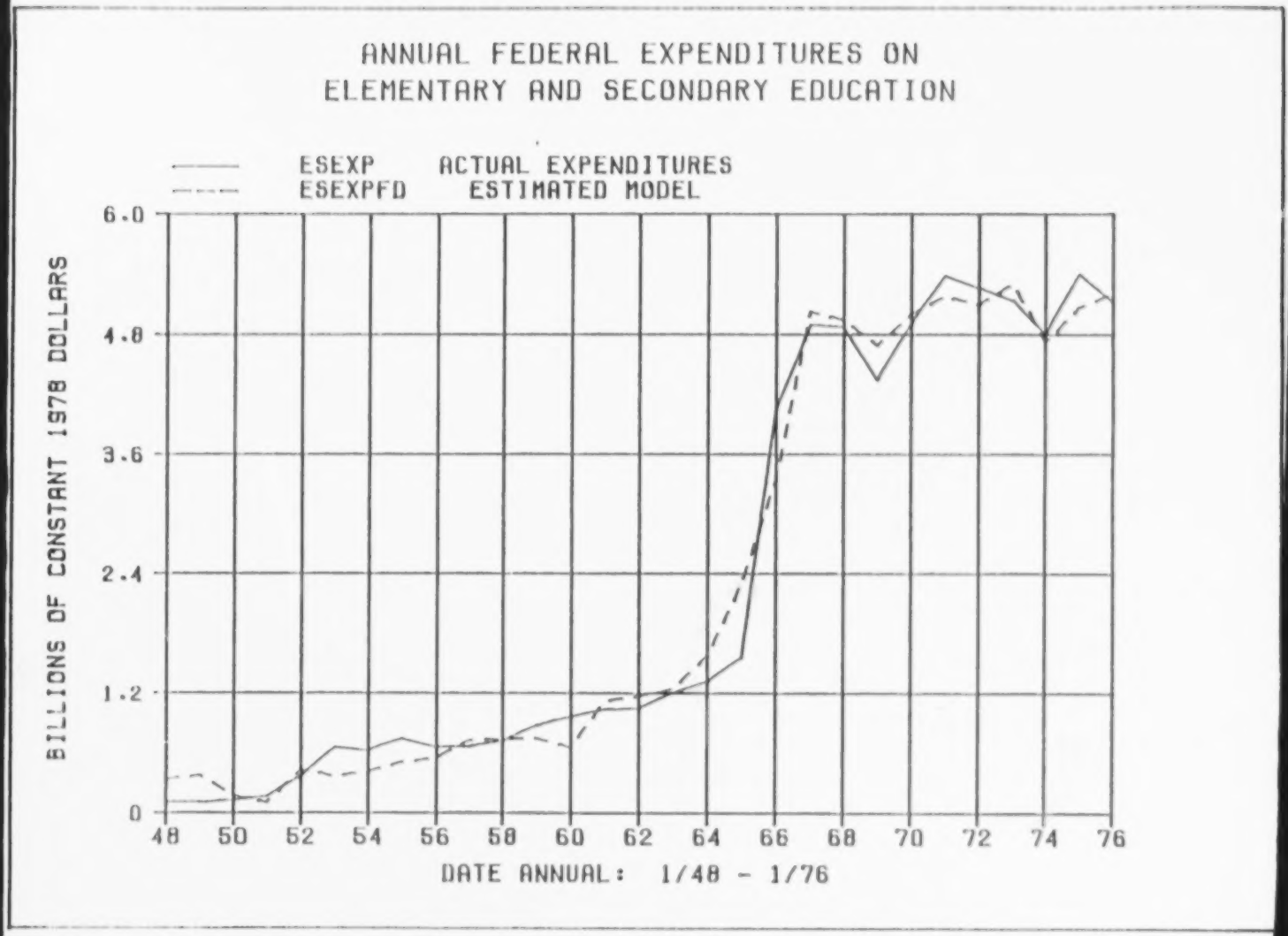

Figure 2. Comparison of estimated federal expenditures for elementary and secondary education based on equation (1) to actual expenditures, 1948-1976.

of state and local government debts and trends in local education agency expenditures were also found to be poor determinants of federal education spending.

Because of the importance of federal higher education expenditures for the estimation of federal expenditures for elementary and secondary education, two equations were estimated to determine the factors that have influenced higher education expenditures since World War II. Equation (2), which estimates annual levels of federal spending for higher education, demonstrates the importance of both federal appropriations made the previous year and the political party composition of the House of Representatives. (In a later section of the paper, the projected level of higher education expenditures based on equation (2) is used in forecasting with equation (1).) Figure 3 compares estimated annual expenditures for higher education based on equation (2) to the actual expenditures for the years 1948-1976. Equation (3) estimates the yearly change in federal higher education expenditures. In this equation, the importance of political factors, available funds (measured by the annual federal budget surplus or deficit), and federal defense expenditures for determining the change in higher education expenditures from one year to the next is demonstrated. Figure 4 compares the estimated annual changes in federal higher education expenditures to the actual annual changes for the years 1948-1976.

Equation (2), Federal Spending for Higher Education

$$HEEXP_t = \underset{(-3.1)}{-.81} + \underset{(21.8)}{.94}HEEXP_{t-1} + \underset{(3.9)}{.73}HOUSE_t$$

Where,

HEEXP = Higher education expenditures (federal)

HOUSE = Ratio of Democrats to Republicans in the House of Representatives

R^2 = .956 STD ERROR = $.34 billion DW-d = 2.1

R^2ADJ = .952 df = 28 DW-h = -.2

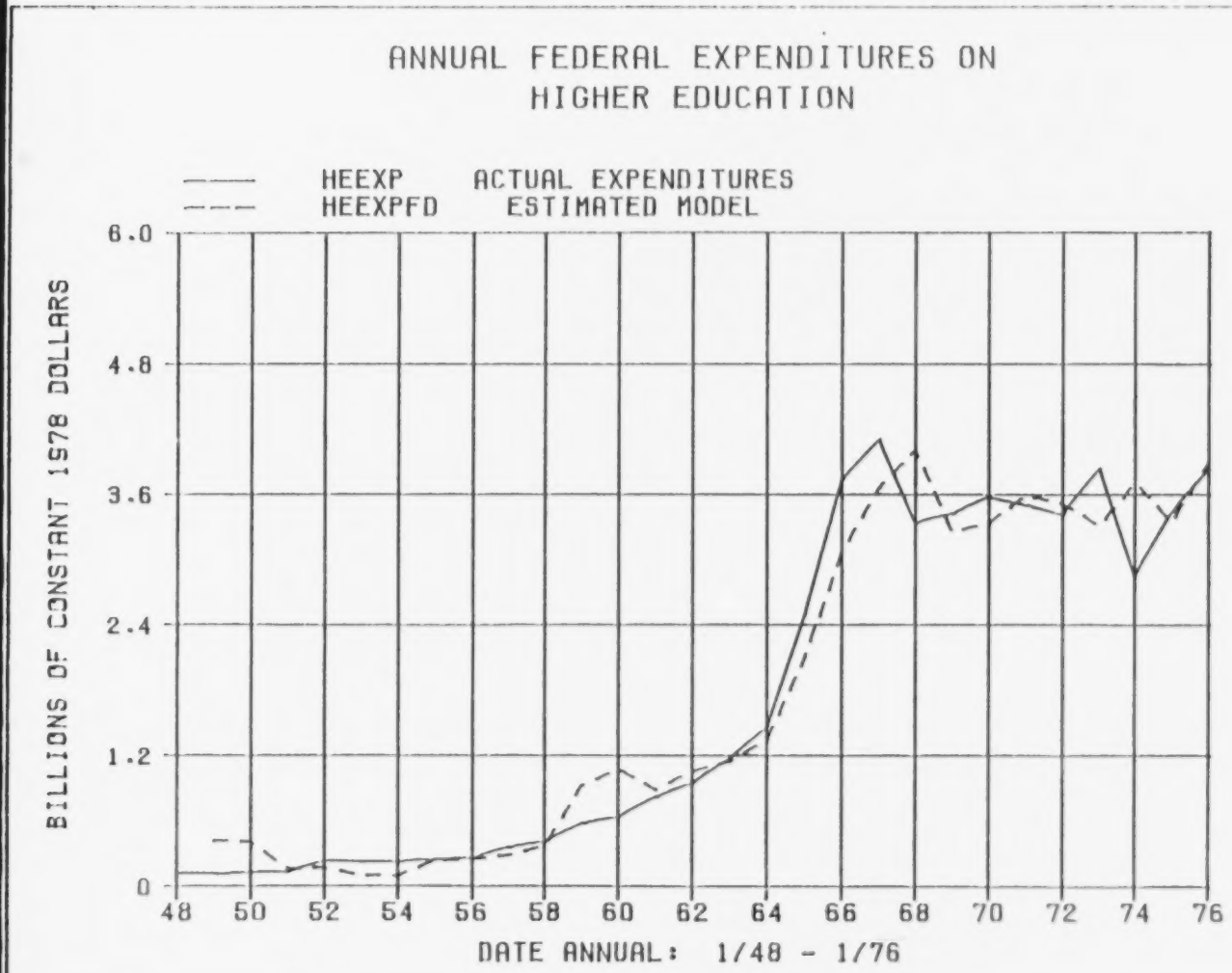

Figure 3. Comparison of estimated federal expenditures for higher education based on equation (2) to actual expenditures, 1948-1976.

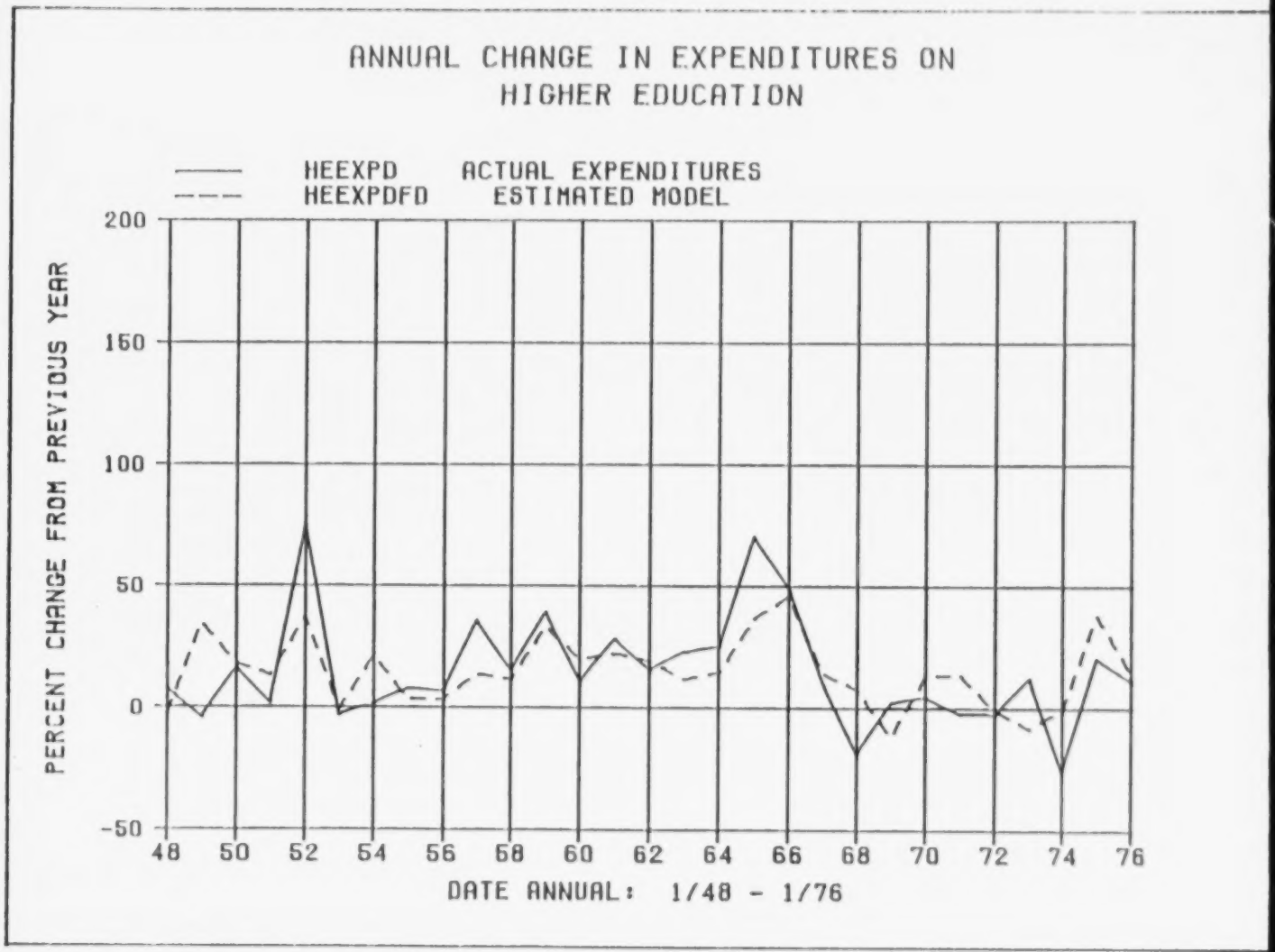

Figure 4. Comparison of estimated annual changes in federal expenditures for higher education based on equation (3) to actual annual changes in expenditures, 1948-1976.

Equation (3), Yearly Changes in Federal Spending for Higher Education

$$HEEXPD_t = -37 + 39HOUSE_t + .49SURPLUS_{t-1} + .20DEFENSED_t$$
$$\quad\quad (-2.5)\quad (3.7)\quad\quad (2.5)\quad\quad (1.9)$$

Where,

HEEXPD = Percentage change from the previous year in federal higher education expenditures

HOUSE = Ratio of Democrats to Republicans in the House of Representatives

SURPLUS = Federal budget surplus (or deficit)

DEFENSED = Percentage change from the previous year in national defense expenditures

R^2 = .420 STD ERROR = 18.2% DW-d = 2.1

R^2ADJ = .351 df = 28

The R^2s of equation (3), which are small when compared to those of equations (1) and (2), attest to the greater difficulty of directly estimating values for the first differences ($Y_t - Y_{t-1}$) in education expenditures. Although the previous year's level of expenditures is a good predictor of the current year's level of expenditures (as is demonstrated by the lagged dependent variables in equations (1) and (2)), one would not expect the percentage change in the previous year to be a good predictor of the percentage change in the current year's expenditures (and, in fact, it is not). Consequently, the dependent variable is not lagged on the right-hand side of equations (3) and (4), and the variance of the dependent variable must be accounted for entirely by other variables. For this reason, these time series of yearly percentage change pose a greater challenge for the estimation of structural equation models of federal education spending, and one would not expect to account for as high a proportion of the variance.

Several politically descriptive variables were tried in estimating equation (2). The relative representation of Democrats to Republicans in the Senate, the House of Representatives, and in the Congress as a whole were used, as was a variable describing the political party affiliation of

the President. All three of the variables relating to composition of the Congress were significant and positive predictors of higher education spending. (The particular variable HOUSE was selected for equation (2) because the t-ratio for this variable was higher than the t-ratios for these other variables.) Political party affiliation of the President, however, was not found to be a significant determinant of higher education expenditures.

Because enrollment variables were believed to be important determinants of federal funding for higher education (on account of the many federal tuition aid programs), equation (2) was also estimated with total higher education enrollment as an independent variable. When total enrollment was used in place of the political variable HOUSE, the equation had a larger standard error ($0.40 billion) and the Durbin-Watson d statistic indicated the possible presence of autocorrelation (i.e., the null hypothesis of zero autocorrelation among residuals could be rejected at the .05 level). When both enrollment and the variable HOUSE were included in equation (2), enrollment was not found to be a statistically significant determinant of higher education expenditures.

Colleges and universities have long been the recipients of federal dollars targeted toward research and development activities. In addition, federal aid programs for college and university students have proliferated since the early 1950s. Much of the federal support for these activities and individuals has been motivated by concern for national defense, although in recent years federal financing of students' college education has become increasingly important for ensuring equal access to societal rewards. During World War II, federal monies supported the work of college and university scientists in the interests of national defense. After the launching of Sputnik, federal monies supported students in higher education institutions in the interests of national security. Today, the government continues to be a strong supporter of college- and university-based research and development activities and individual scientific pursuits in the interests of national self-sufficiency and preparedness for international conflict. As is shown in equation (3), therefore, higher education expenditures have tended to increase in years when defense

expenditures increased--when the federal government felt insecure about the international balance of power.

Taken together, equations (1)-(3) suggest that (1) federal support for higher education is predictive of elementary and secondary expenditures (but, surprisingly, we did not find the converse to be true); (2) educational spending tends to increase following a small federal deficit and tends to be cut back following a large federal deficit; (3) a large Democratic majority in the House of Representatives has tended to result in the largest increases in educational spending; and (4) federal educational spending has been responsive to conditions related to the perceived role of education in achieving national defense goals. In the next section, federal spending for elementary and secondary education is related explicitly to the perceived role of education in achieving major societal goals.

Yearly Changes in Federal Spending for Elementary and Secondary Education

Elementary and secondary education and higher education serve fundamentally the same social purpose--they provide opportunities for students to acquire the necessary skills for effectively functioning in society. The more specific roles of education vary as a function of level, however. In particular, elementary and secondary education helps to socialize youth, providing them with skills for coping with the demands of everyday life, while higher education equips students with the skills to develop and use new knowledge and technology. These different emphases are reflected in the particular national goals associated with the various levels of education.

From the federal perspective, elementary and secondary schools serve as a "melting pot"--bringing together students from diverse sociocultural backgrounds and helping them to adjust to the demands of the common social structure. In the early part of this century, this function of the elementary and secondary grades was especially well recognized because of the large numbers of immigrants in need of a rapid introduction to the manners

and customs of the United States. This continues to be one of the primary purposes of elementary and secondary education, although the function may be perceived somewhat differently now. Title I of the Elementary and Secondary Education Act aimed to ensure that students who were educationally (and economically) disadvantaged were not denied the opportunity to acquire skills for getting along in society--to work, to study, and to enjoy leisure activities fully. Here again was a variation on the melting pot theme, providing educational services as needed to students from diverse backgrounds to help ensure their equal access to the benefits of society. In equation (4), an indication of the "breakdown" in youth socialization, the number of youths less than 18 years old who are arrested (YOUTHARRD), is included along with variables describing political and economic conditions to estimate the proportional change in federal elementary and secondary expenditures.

Equation (4), Yearly Changes in Federal Elementary and Secondary Expenditures

$$\underset{}{ESEXPD_t} = \underset{(-2.0)}{-58} + \underset{(2.6)}{49HOUSE_t} + \underset{(3.5)}{1.2SURPLUS_{t-1}} + \underset{(3.6)}{2.6RECEIPTSD_t} + \underset{(2.0)}{.42YOUTHARRD_{t-1}}$$

where,

ESEXPD = Percentage change from the previous year in federal elementary and secondary expenditures

HOUSE = Ratio of Democrats to Republicans in the House of Representatives

SURPLUS = Federal budget surplus (or deficit)

RECEIPTSD = Percentage change from the previous year in federal budget receipts

YOUTHARRD = Percentage change from the previous year in the number of arrests of persons under 18 years old.

R^2 = .513 STD ERROR = 29.9% DW-d = 2.1

R^2ADJ = .428 df = 27

This equation suggests that annual changes in federal elementary and secondary expenditures are a function of changes in the availability of federal funds (SURPLUS and RECEIPTSD), the political party affiliation of members of the House of Representatives (HOUSE), and changes in the number of young persons not able to function acceptably in society (YOUTHARRD). The variable describing the change in total number of arrests of persons under 18 years old is lagged one year, because it is unlikely that federal authorizations and appropriations could respond immediately (i.e., in the same year) to changes in the status of youth. Equation (4), in examining variables believed to affect short-term fluctuations in federal spending for elementary and secondary education, thus calls attention to the responsiveness of the federal government to signs of breakdown in the socialization of young people. Figure 5 compares the estimated annual changes in expenditures for elementary and secondary education based on equation (4) to actual annual changes in these expenditures for the years 1949-1976.

Forecasting Federal Expenditures for Elementary and Secondary Education

Equations (1) and (4) can be used to forecast federal expenditures for elementary and secondary education. Equation (2) can be used to project higher education expenditures, and these projections can be used in forecasting with equation (1). In this section, forecasts based on equations (1), (2), and (4) are compared to projections based on a variety of univariate forecasting methods. Since our focus in this paper is on elementary and secondary education expenditures, projections based on equation (3) were not made.

Forecasting Using Structural Equation Models

To test the forecasting accuracy of equations (1), (2), and (4), projections were made for years whose values were known but withheld from the models. Specifically, each equation was first estimated using data up through 1974, and 1975 values were forecast. Then, the procedure was repeated with the actual data from 1975 included in the model and 1976

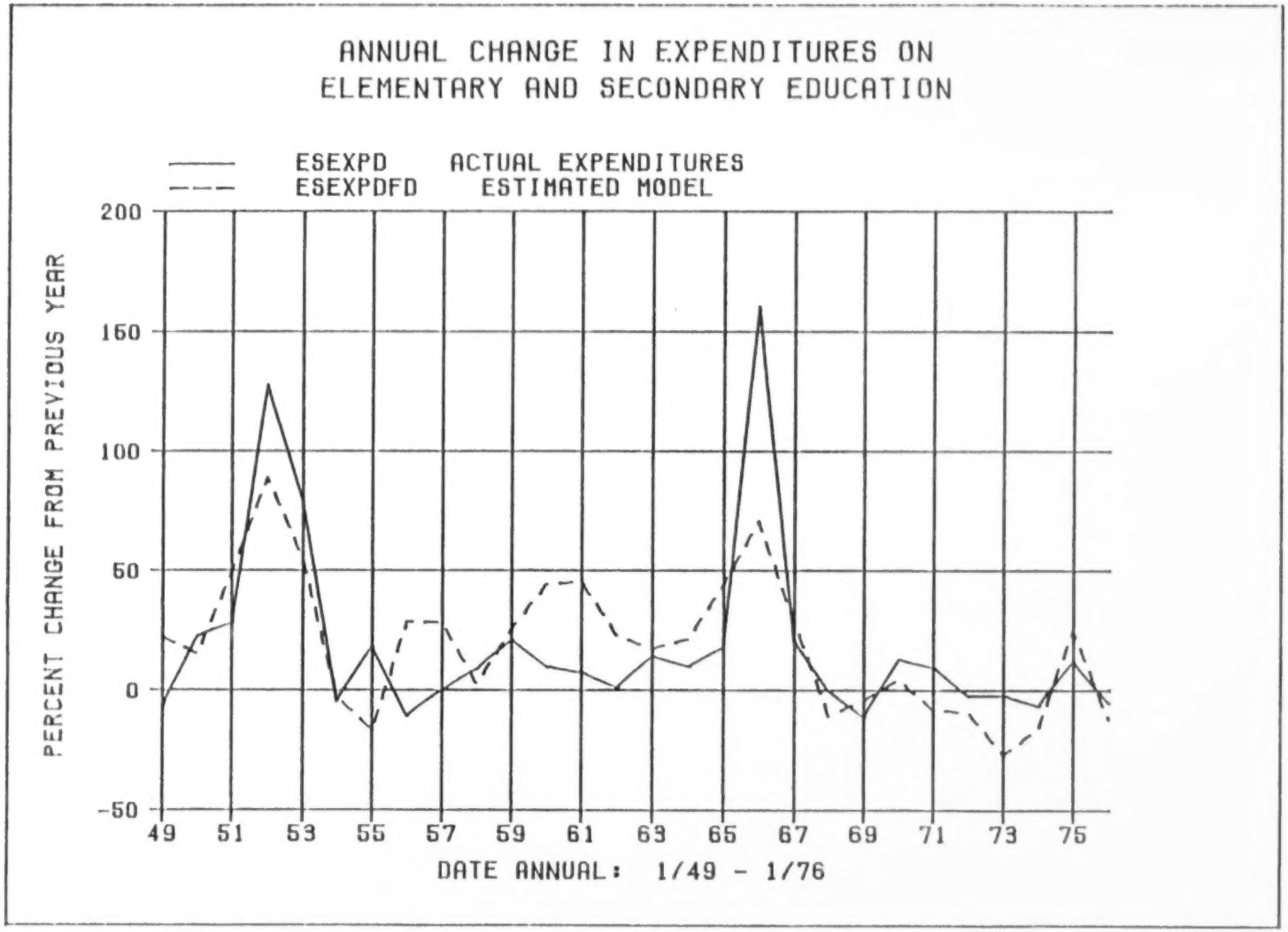

Figure 5. Comparison of estimated annual changes in federal expenditures for elementary and secondary education based on equation (4) to actual annual changes in expenditures, 1949-1976.

values forecasted. Each forecast is thus for one year beyond the last data point included in the models. Forecasts of more than one year into the future can be expected to be less accurate.

Two methods were used in comparing forecasted values to actual values to measure the forecasting accuracy of these equations. In the first method, the absolute difference between the actual and forecasted values for one year (i.e., the forecast error) is divided by the actual values for that year. The result is the mean absolute percentage error (MAPE) for the forecast. The MAPE is an appropriate statistic for evaluating forecasts when one can assume that the variance of the series is a direct function of the mean (i.e., as the series increases in value, the variability increases proportionally). Consequently, MAPE is the appropriate statistic for evaluating the forecasting accuracy of equations (1) and (2). However, problems arise when the MAPE is used to assess the accuracy of forecasts made for variables whose expected values are near zero and whose values can be negative. In these circumstances, an accurate forecast could still have a very large or undefined MAPE depending on the actual value of the series at that point. Thus, to assess the forecasting accuracy of equation (4), a second measure of accuracy was used in which the forecasting error is divided by the standard deviation of the series. This measure of forecasting accuracy is appropriate whenever the time series is stationary (i.e., is not either increasing or decreasing in the long run but is fluctuating around some value). In addition to solving the problems encountered by the MAPE when zero or negative values are observed, this method explicitly takes into account the variability of the series in assessing how good or poor a forecast was.

Table 1 presents the results of the one-year-ahead forecasts made for 1975 and 1976 using equations (1), (2), and (4). In addition, forecasted 1975 and 1976 values for the variable HEEXP were substituted for the actual values of this variable in projecting 1975 and 1976 values of ESEXP using equation (1). The purpose of this substitution was to assess the feasibility of making forecasts of elementary and secondary expenditures when the actual levels of higher education expenditures for these years are unknown. The performance of equation (1) using actual versus projected

Table 1

Results of One-Period-Ahead Forecasts Made with Equations (1), (2), and (4)

Equation	Forecast Value	Actual Value	Forecast Error / Actual Value (MAPE)	Forecast Error Standard Deviation
1975				
Equation (1):				
$ESEXP = .002 + .58ESEXP_{t-1} + .66HEEXP_{t} + .01SURPLUS_{t-1}$	$5.01 billion	$5.40 billion	7.2%	not appropriate
Equation (2):				
$HEEXP = -.81 + .94HEEXP_{t-1} + .72HOUSE_{t}$	$3.35 billion	$3.44 billion	2.6%	not appropriate
Equation (4):				
$ESEXPD = -59 + 50HOUSE_{t} + 1.2SURPLUS_{t-1} + 2.6RECEIPTSD_{t} + .41YOUTHARRD_{t-1}$	26.81%	12.17%	not appropriate	.36σ
Equation (1), Using Projected Values of HEEXP:				
$ESEXP + .002 + .58ESEXP_{t-1} + .66HEEXP_{t} + .01SURPLUS_{t-1}$	$4.95 billion	$5.40 billion	8.3%	not appropriate
1976				
Equation (1):				
$ESEXP = .002 + .6ESEXP_{t-1} + .65HEEXP_{t} + .01SURPLUS_{t-1}$	$5.23 billion	$5.13 billion	1.9%	not appropriate
Equation (2):				
$HEEXP = -.83 + .94HEEXP_{t-1} + .74HOUSE_{t}$	$3.91 billion	$3.81 billion	2.1%	not appropriate
Equation (4):				
$ESEXPD = -56 + 47HOUSE_{t} + 1.2SURPLUS_{t-1} + 2.7RECEIPTSD_{t} + .41YOUTHARRD_{t-1}$	-15.85%	-4.91%	not appropriate	.28σ
Equation (1), Using Projected Values of HEEXP:				
$ESEXP = .002 + .6ESEXP_{t-1} + .65HEEXP_{t} + .01SURPLUS_{t-1}$	$5.28 billion	$5.13 billion	2.9%	not appropriate

values of higher education expenditures can be compared in Table 1. From this comparison, it appears that tenable forecasts of elementary and secondary expenditures can be made when only projected values of higher education expenditures are available.

Comparisons of Multivariate and Univariate Forecasts

As J. Scott Armstrong (1978) has rightly noted, statements of forecasting accuracy are most useful when they involve comparisons among alternative forecasting methodologies. The best way to evaluate the forecasting ability of a model is, indeed, to compare it with other models for forecasting the same series. For this reason, three univariate approaches to forecasting the 1975 and 1976 values of ESEXP, HEEXP, and ESEXPD were tried. First, linear regressions were run using time as the independent variable. This method bases the projection of values on the assumption that the series follows a strictly linear trend. Second, linear regressions were run using (only) the previous year's value of the dependent variable to predict its current value. The third approach made use of a three-period moving average model. This model uses the average of the previous three values of the dependent variable to estimate its present value. In using this procedure, one assigns equal weights to each of the three previous values.

Table 2 evaluates the forecasting accuracy of each of these univariate procedures and compares their accuracy to the accuracy of forecasts made with equations (1), (2), and (4). In four out of the six forecasting situations, the multivariate models outperformed the univariate method that used time to forecast future values, and in five out of the six cases, the multivariate models outperformed the univariate method that used the previous year's value. In contrast, in four out of six cases, the multivariate models produced less accurate forecasts than did the three-period moving average approach to projecting series values. What must be kept in mind in evaluating the utility of these various forecasting methods, however, is that the multivariate models do provide greater insight into the factors that determine the levels of federal educational spending, whereas the univariate models do not. Because equation (4), for example, explicitly relates the size of the federal budget surplus or

TABLE 2

Comparison of the Forecasting Accuracy of Multivariate and Univariate Procedures: 1975

Dependent Variable	Forecasting Method	Equation	Forecast Value	Actual Value	Forecast Error / Actual Value (MAPE)	Forecast Error / Standard Deviation
ESEXP	Multivariate	$ESEXP = .002 + .58ESEXP_{t-1} + .66HEEXP_{t} + .01SURPLUS_{t-1}$	$5.01 billion	$5.40 billion	7.2%	not appropriate
Federal elementary and secondary expenditures	Univariate (time)	$ESEXP = -1188 + 221.7TIME$	$5.24 billion	$5.40 billion	3.0%	not appropriate
	Univariate (previous value)	$ESEXP = 202.3 + .98ESEXP_{t-1}$	$4.94 billion	$5.40 billion	8.5%	not appropriate
	Univariate (moving average)	$ESEXP = .33ESEXP_{t-1} + .33ESEXP_{t-2} + .33ESEXP_{t-3}$	$5.07 billion	$5.40 billion	6.1%	not appropriate
HEEXP	Multivariate	$HEEXP = -.81 + .94HEEXP_{t-1} + .72HOUSE_{t}$	$3.35 billion	$3.44 billion	2.6%	not appropriate
Federal higher education expenditures	Univariate (time)	$HEEXP = -873.7 + 164.8TIME$	$3.90 billion	$3.44 billion	13.4%	not appropriate
	Univariate (previous value)	$HEEXP = 159 + .96HEEXP_{t-1}$	$2.90 billion	$3.44 billion	15.7%	not appropriate
	Univariate (moving average)	$HEEXP = .33HEEXP_{t-1} + .33HEEXP_{t-2} + .33HEEXP_{t-3}$	$3.37 billion	$3.44 billion	2.0%	not appropriate
ESEXPD	Multivariate	$ESEXPD = -59 + 50HOUSE_{t} + 1.2SURPLUS_{t-1} + 2.6RECEIPTSD_{t} + .41YOUTHARMD_{t-1}$	26.81%	12.17%	not appropriate	.36σ
Annual change in federal elementary and secondary expenditures	Univariate (time)	$ESEXPD = 29.1 - .7ITIME$	9.17%	12.17%	not appropriate	.07σ
	Univariate (previous value)	$ESEXPD = 15.4 + .24ESEXPD_{t-1}$	13.90%	12.17%	not appropriate	.04σ
	Univariate (moving average)	$ESEXPD = .33ESEXPD_{t-1} + .33ESEXPD_{t-2} + .33ESEXPD_{t-3}$	-1.65%	12.17%	not appropriate	.39σ

TABLE 2, continued

Comparison of the Forecasting Accuracy of Multivariate and Univariate Procedures: 1976

Dependent Variable	Forecasting Method	Equation	Forecast Value	Actual Value	Forecast Error Actual Value (MAPE)	Forecast Error Standard Deviation
ESEXP	Multivariate	$ESEXP = .002 + .6ESEXP_{t-1} + .65HEEXP_{t} + .01SURPLUS_{t-1}$	$5.23 billion	$5.13 billion	1.9%	not appropriate
Federal elementary and secondary expenditures	Univariate (time)	$ESEXP = -1198.9 + 222.8TIME$	$5.48 billion	$5.13 billion	6.8%	not appropriate
	Univariate (previous value)	$ESEXP = 195.3 + 1.0ESEXP_{t-1}$	$5.58 billion	$5.13 billion	8.8%	not appropriate
	Univariate (moving average)	$ESEXP = .33ESEXP_{t-1} + .33ESEXP_{t-2} + .33ESEXP_{t-3}$	$5.12 billion	$5.13 billion	.2%	not appropriate
HEEXP	Multivariate	$HEEXP = -.81 + .94HEEXP_{t-1} + .74HOUSE_{t}$	$3.91 billion	$3.83 billion	2.1%	not appropriate
Federal higher education expenditures	Univariate (time)	$HEEXP = -841.4 + 161.5TIME$	$4.00 billion	$3.83 billion	4.4%	not appropriate
	Univariate (previous value)	$HEEXP = 160.5 + .97HEEXP_{t-1}$	$3.50 billion	$3.83 billion	8.6%	not appropriate
	Univariate (moving average)	$HEEXP = .33HEEXP_{t-1} + .33HEEXP_{t-2} + .33HEEXP_{t-3}$	$3.38 billion	$3.83 billion	11.7%	not appropriate
ESEXPD	Multivariate	$ESEXPD = -56 + 47HOUSE_{t} + 1.2SURPLUS_{t-1} + 2.7RECEIPTSD_{t} + .41YOUTHARRD_{t-1}$	-15.85%	-4.91%	not appropriate	.28σ
Annual change in federal elementary and secondary expenditures	Univariate (time)	$ESEXPD = 28.9 - .69TIME$	8.89%	-4.91%	not appropriate	.35σ
	Univariate (previous value)	$ESEXPD = 15.3 + .24ESEXPD_{t-1}$	18.28%	-4.91%	not appropriate	.59σ
	Univariate (moving average)	$ESEXPD = .33ESEXPD_{t-1} + .33ESEXPD_{t-2} + .33ESEXPD_{t-3}$	1.16%	-4.91%	not appropriate	.15σ

deficit to the annual change in federal expenditures, it was able to accurately forecast the downturn in educational expenditures from 1975 to 1976 that resulted in part from a $25 billion increase in the federal budget deficit in 1975. While the three-period moving average forecast of the 1976 value of the variable ESEXPD is nearer to the actual value for that year, the values projected for 1975 and 1976 using this univariate approach give the incorrect impression that there was an upturn in educational spending between these years from -3.65% to +1.16%.

The results in Table 2 also serve to underscore the usefulness of estimating both the level of educational expenditures and the first differences of this series, or the annual change in expenditures. Equation (1) appears to be more accurate than equation (4) in predicting 1975 and 1976 values for its dependent variable. However, equation (1) fails to project the downturn in federal spending from 1975 to 1976. The reason for this is that equation (1) includes independent variables that affect the long-term trends in federal spending for education. Thus, forecasts based on this model are less likely to accurately project the trend in spending from one year to the next. Equation (4), which from 1975 to 1976 accurately forecasts the downturn in expenditures does so precisely because it includes variables that were found to affect the short-term fluctuations in the expenditures variables.

Summary and Conclusions

Structural equation models of the annual level of federal expenditures for elementary and secondary education and for higher education were estimated using time-series data extending back from the present to 1947. Models were also estimated for the annual changes in expenditures for these federal budget categories. It was shown that the pattern of federal elementary and secondary education expenditures has closely followed the pattern of federal expenditures for higher education. Factors that have influenced federal higher education expenditures since World War II and have thereby indirectly affected expenditures for elementary and secondary education have included the political party affiliation of the House of

Representatives, the size of the federal budget surplus or deficit, and the level of federal expenditures for national defense. Factors that have directly influenced elementary and secondary expenditures since 1947 have included the political party affiliation of the House of Representatives, the size of the federal budget surplus or deficit, the number of arrests of persons under 18 years of age, and, as noted above, federal expenditures for higher education.

To test the forecasting accuracy of the models that were developed, projections were made for years whose values were known but withheld from the models. Each forecast that was made was for one year beyond the last data point included in the model. Forecasts of more than one year into the future can be expected to be less accurate. Projections were also made using three univariate techniques (linear regression against time, linear regression against the previous year's value of the series, three-period moving average), and these projections were compared to those based on the multivariate models. The results indicated that multivariate forecasts were usually superior to univariate forecasts based on linear regression. When considering only the absolute accuracy of single-year estimates, the three-period moving average model performed better than the multivariate forecasts in four out of six cases. However, the accuracy with which single-year estimates are made is but one factor in the evaluation of the utility of a forecasting method. Multivariate models of short-term fluctuations and long-term trends provide greater insight into the factors that influence changes in time series. As a result, these models are likely to be more accurate in predicting series trends when the influencing factors change suddenly. In addition, and often more importantly, multivariate modeling techniques increase our understanding of the interactions within and between social systems, while univariate models do not promote knowledge at all.

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APPENDIX

Figures Illustrating the Levels of the Time Series
Included in Structural Equation Models of
Federal Educational Expenditures

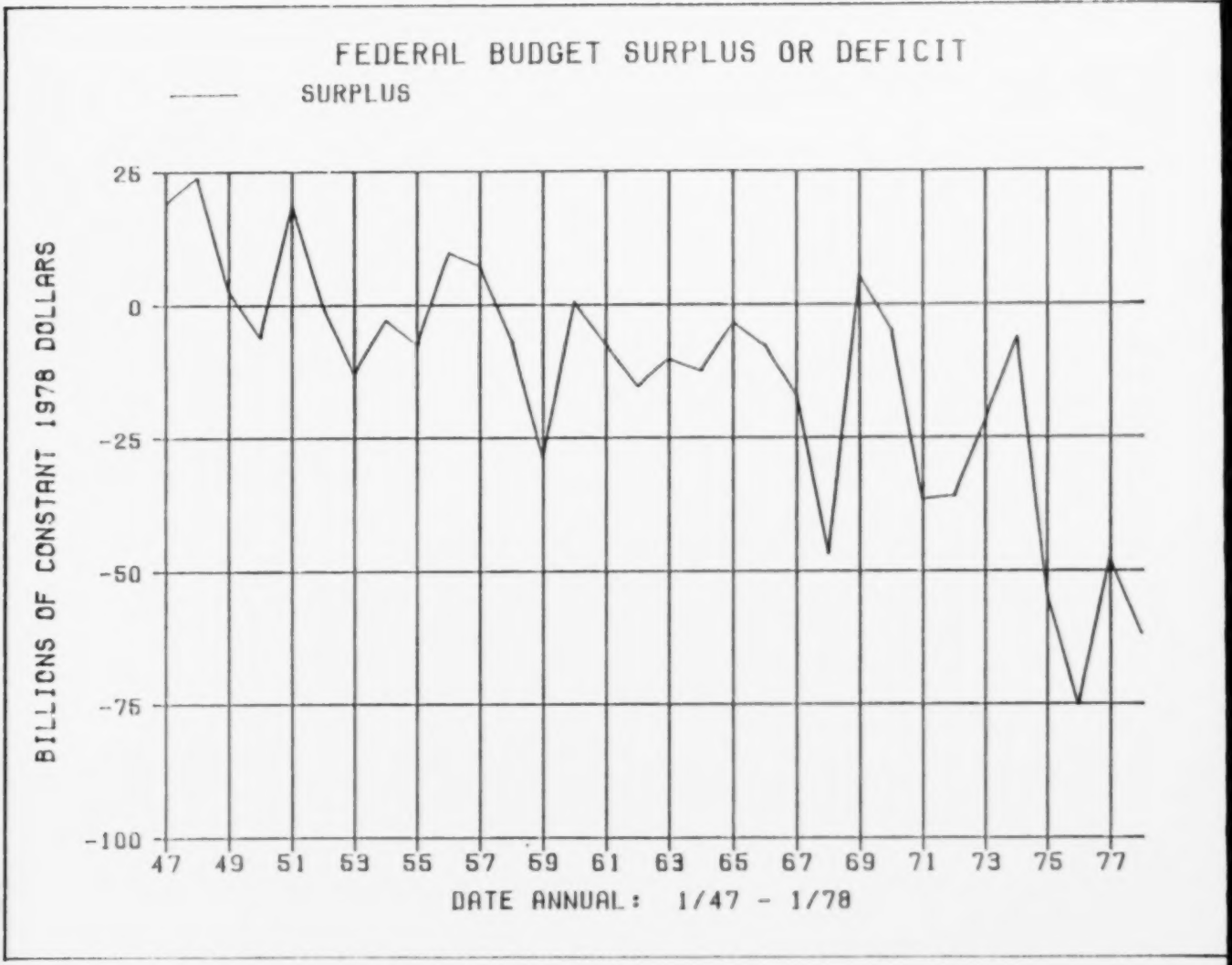

Figure 6. Federal budget surplus or deficit, 1947-1978.

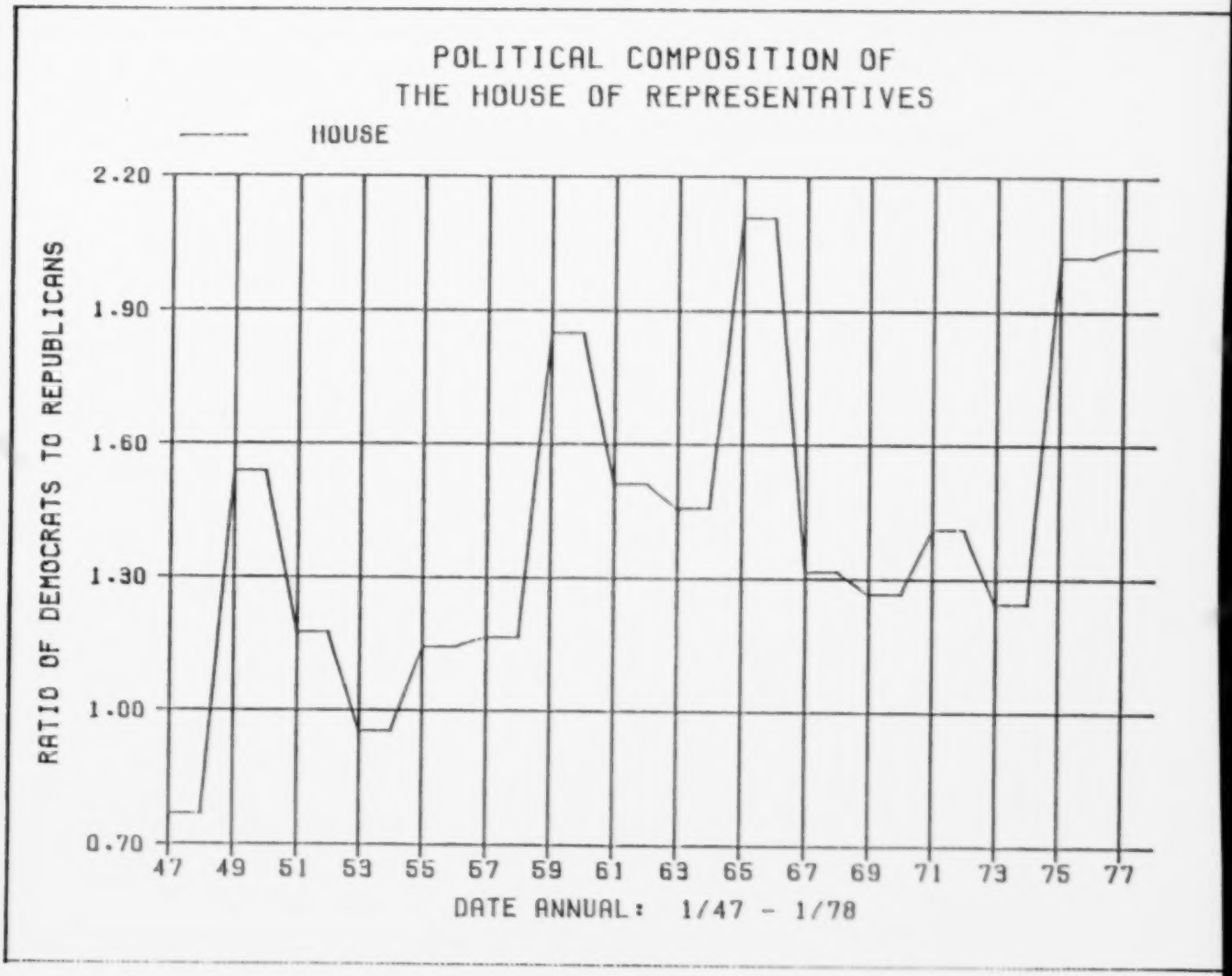

Figure 7. Political composition of the House of Representatives, 1947-1978.

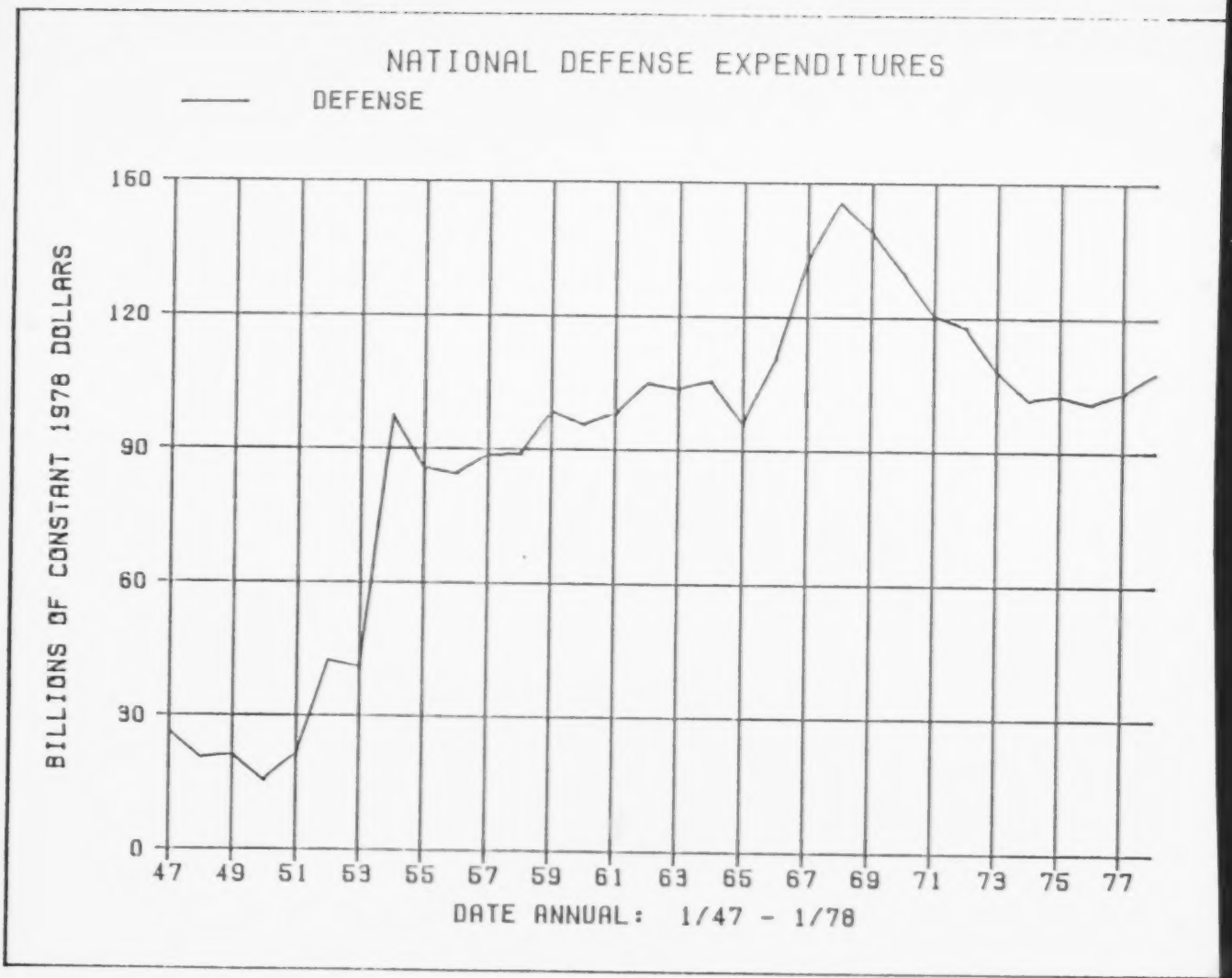

Figure 8. National defense expenditures, 1947-1978.

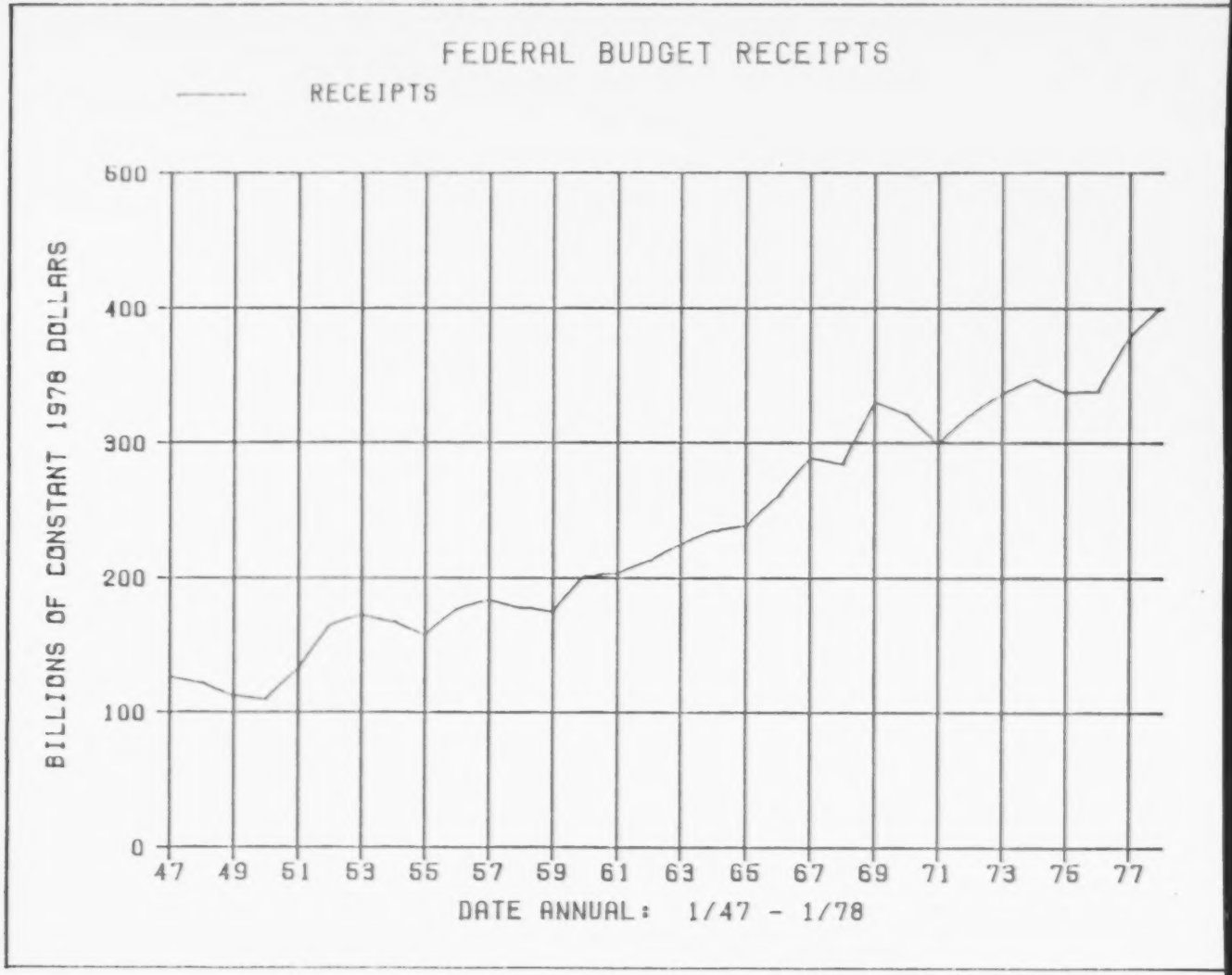

Figure 9. Federal budget receipts, 1947-1978.

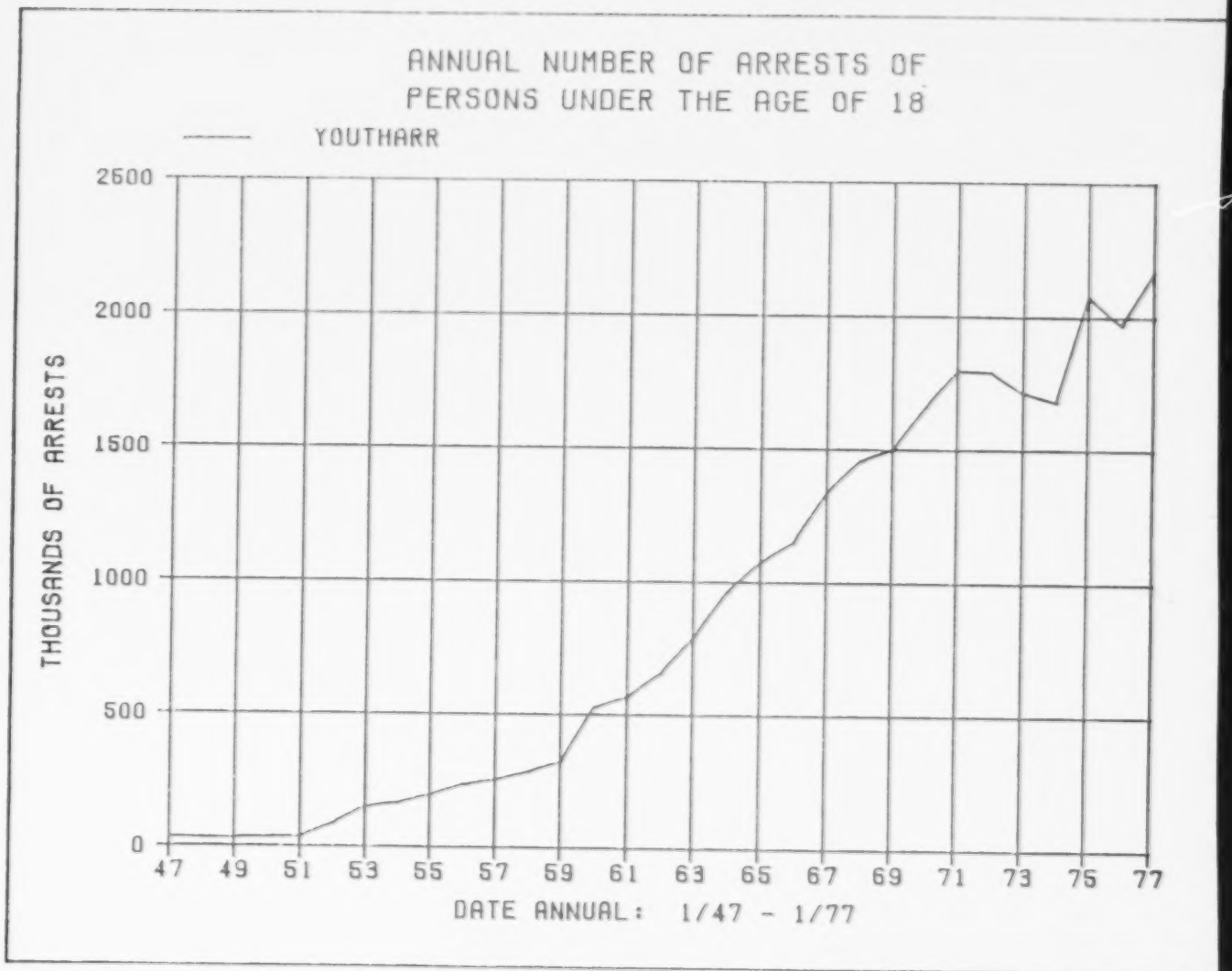

Figure 10. Annual number of arrests of persons under the age of 18, 1947-1977.